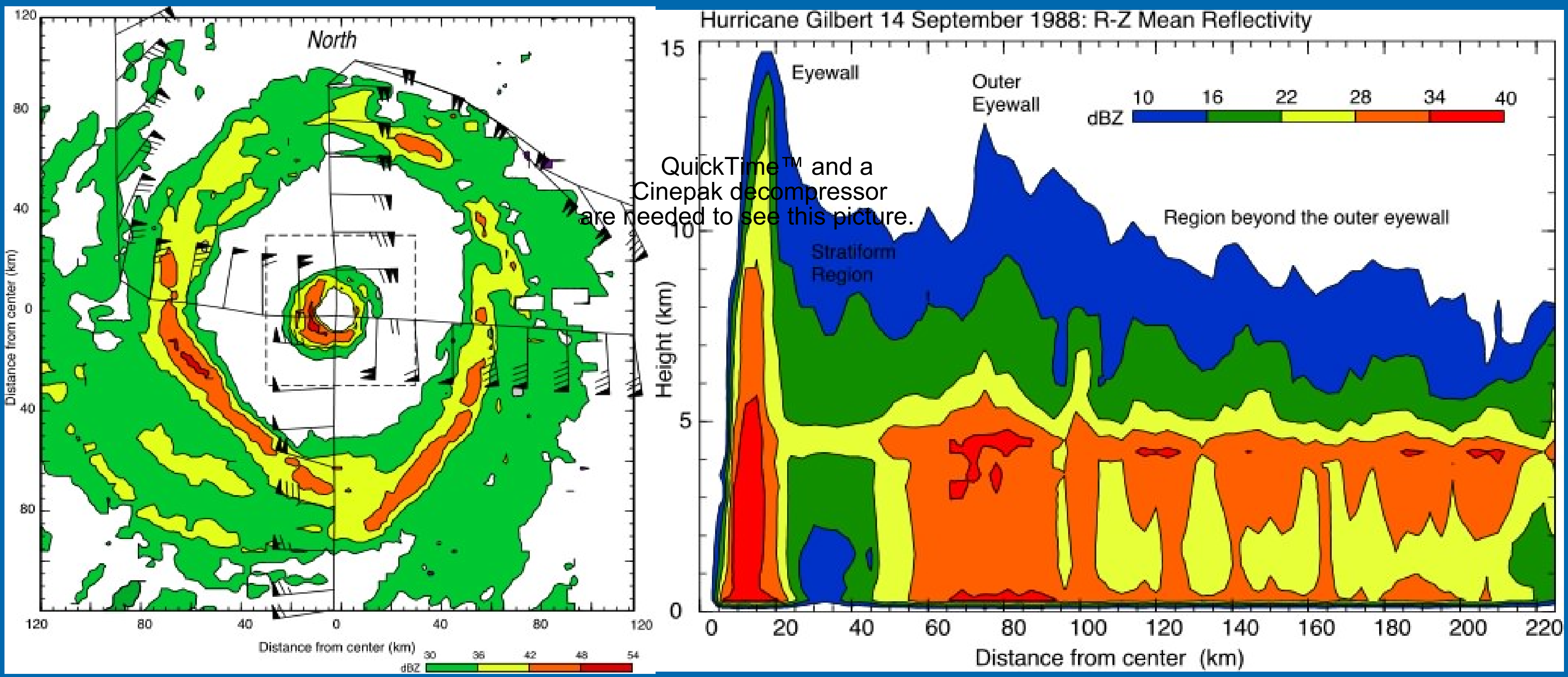
AOML STRENGTHS

- Tropical Cyclone
  - Dynamics/Structure
  - Precipitation and Microphysics
  - Remote sensing (active and passive)
  - Model evaluation
- Tropical Precipitation Observations
- Radar Observations and Analysis

Characteristics of TC precipitation

- ✓ Vortex constrains small scale (time scale V_θ/r).
- ✓ Perfect laboratory for testing QPF techniques.
- ✓ If can't improve TC QPF, then hopeless.

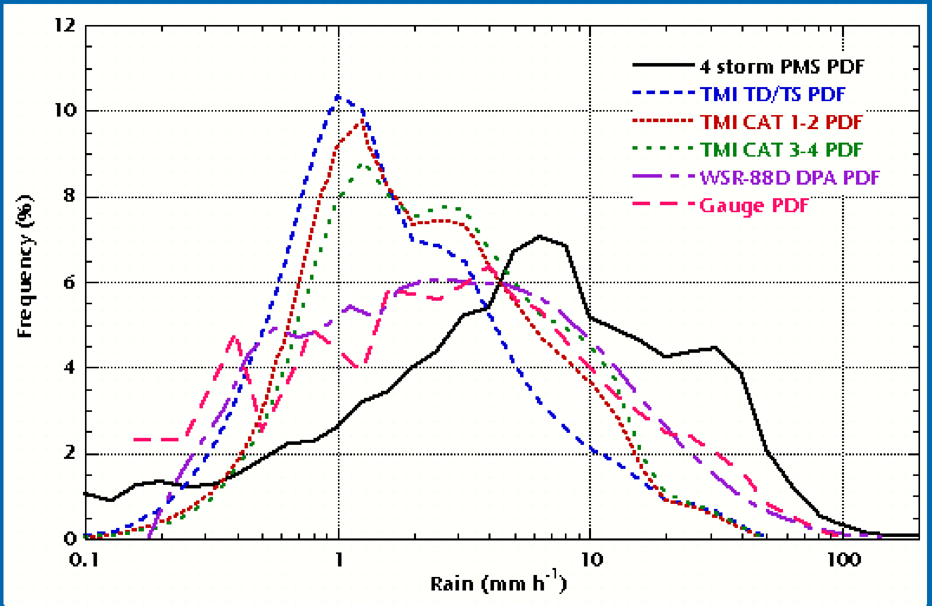


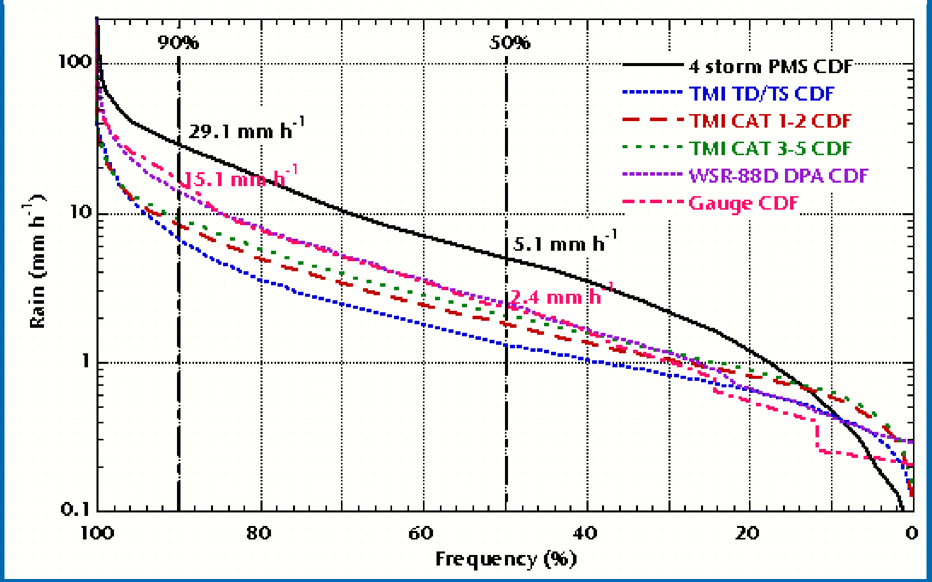
Observations

- Only database of aircraft observations in hurricanes in the world.
- Have several decades of obs, including radar reflectivity, winds, precipitation, thermodynamics
- http://www.aoml.noaa.gov/hrd/project2003/microphysics.html

QPE Techniques in TCs

- Scale dependence:
  - 10-s PMS sample area ~1 m^{-2}
  - 1-h gage sample area ~1-16000 m^2 (advection speed dependent)
  - 1-h radar sample area 16 km^2
  - TMI sample are 25 km^2
  - $\geq 10^3$ gages to cover radar/TMI sample area
- PDF narrower and skewed to smaller R as area increases





QPE techniques in TCs:

✓ Disdrometers, Gauges, Radars, and TRMM

- Drop size distributions (DSD) and Z-R relations

✓DSD yeilds:

$$R \approx \sum[v(D)D^3 n(D)]$$

$$Z \approx \sum[D^6 n(D)]$$

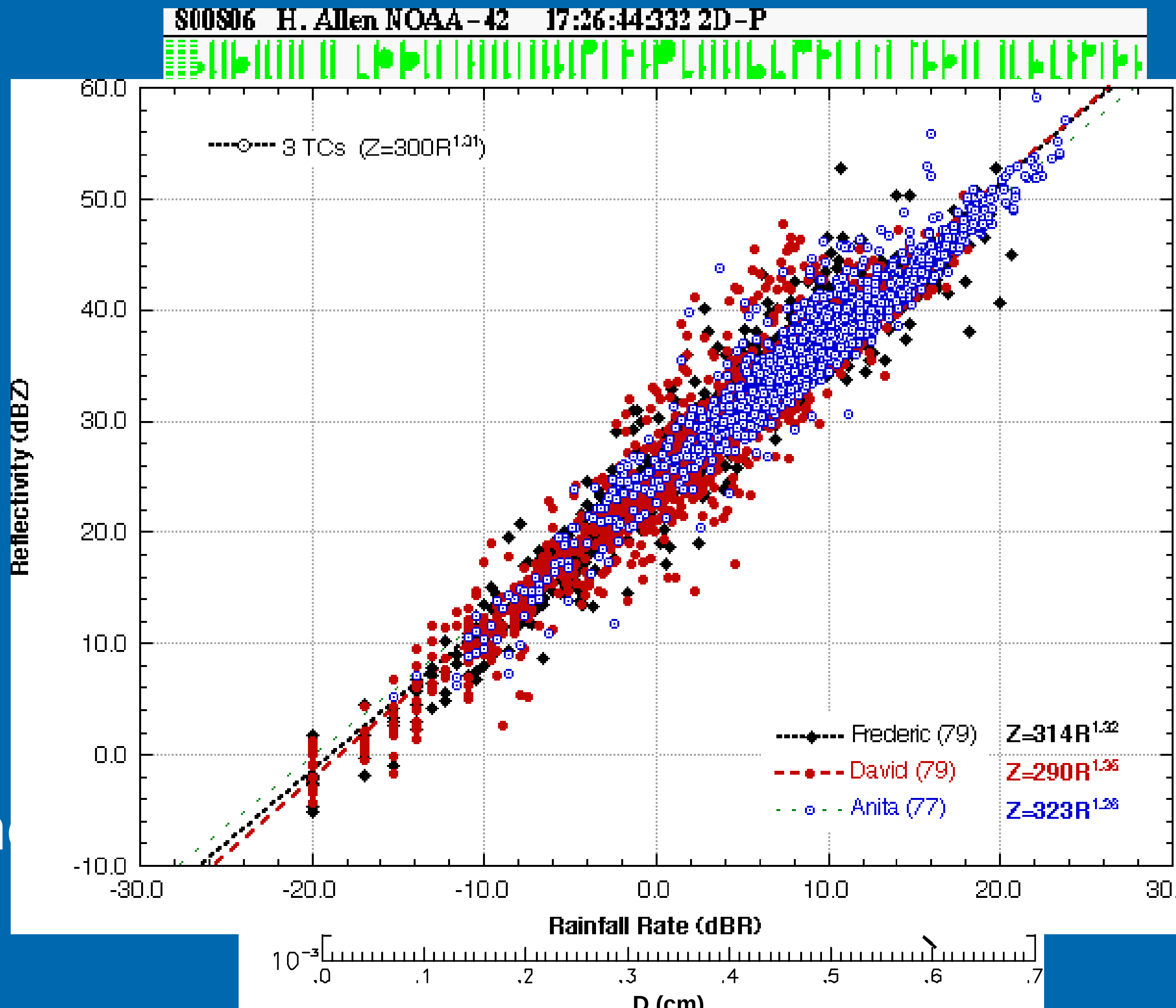
terminal velocity

$v(D)=\alpha D^{0.67}$

✓log Z vs log R

$Z=aR^b$

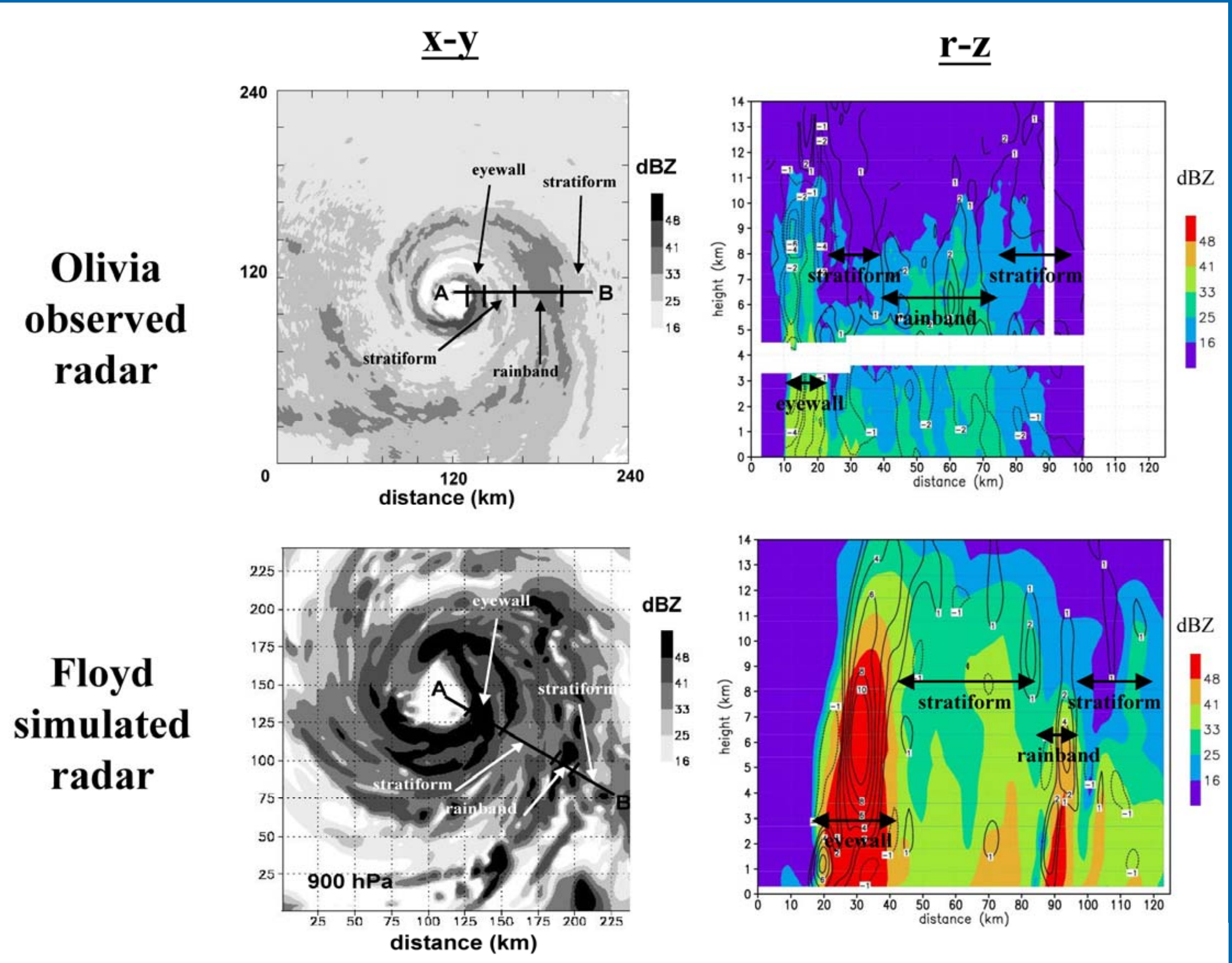
Note: sample volume mismatch



Modeling Efforts

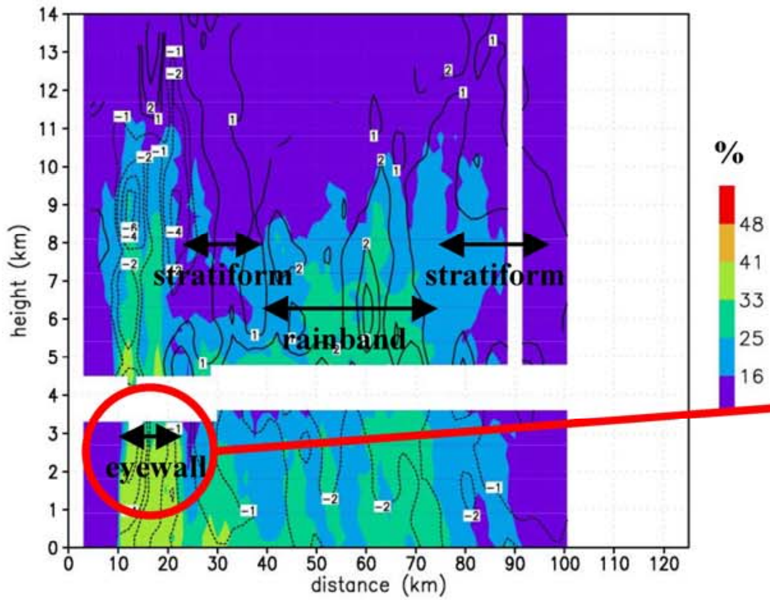
- Use MM5 now, HWRF soon
- Problem:
  - Reflectivity too high
- Test finer resolution
- Test microphysical parameterization
- Compare model results with observations, especially rainfall
- http://www.aoml.noaa.gov/hrd/project2005/rainfall.html
- http://www.aoml.noaa.gov/hrd/project2003/HWRF.html

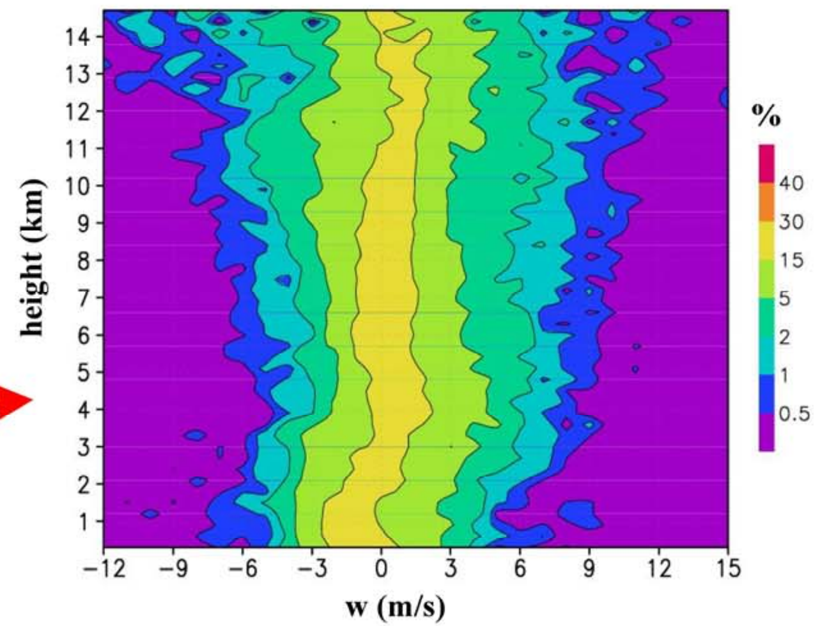
MM5 Hi-Res Simulation



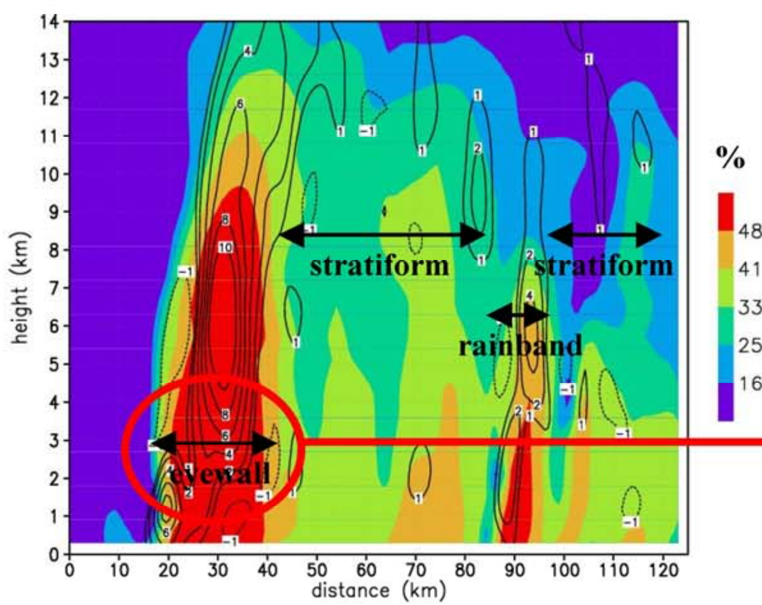
Eyewall vertical motion statistics

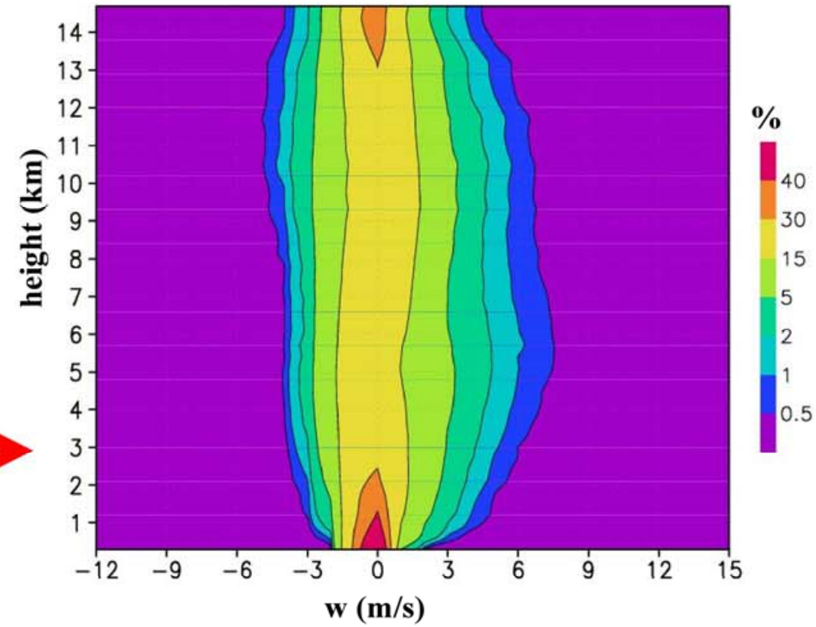
radar





model





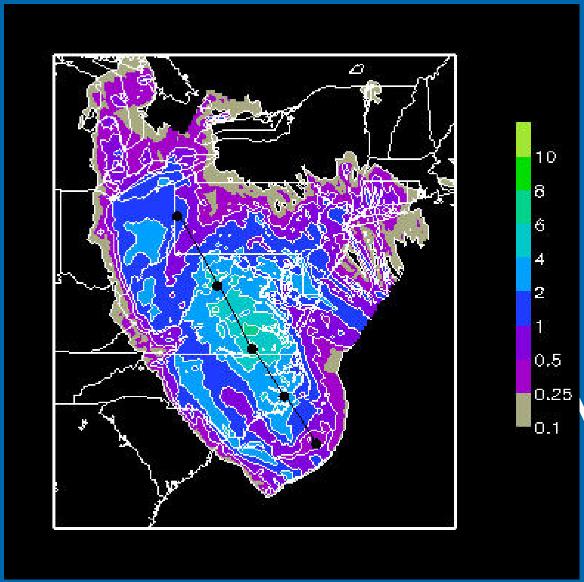
Rainfall statistics for observations and forecasts of 24-h rain from 1200 UTC 18 September for Isabel (2003)

	Total areal coverage of rain (x 10^6 km^2)	Total rain flux (x 10^6 in-km^2)	Mean R (in)
Stage4	1.201	1.536	1.28
R-CLIPER	1.936	2.191	1.13
GFDL	1.933	2.453	1.27
GFS	1.877	1.485	0.79
Eta	1.404	2.528	1.28

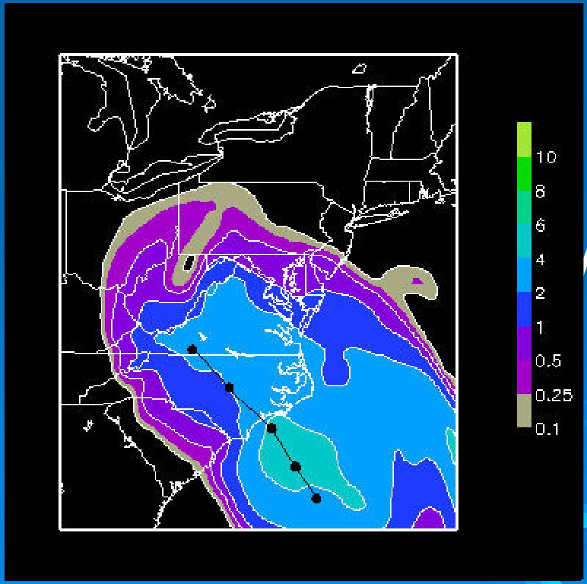
Rogers et al 2004

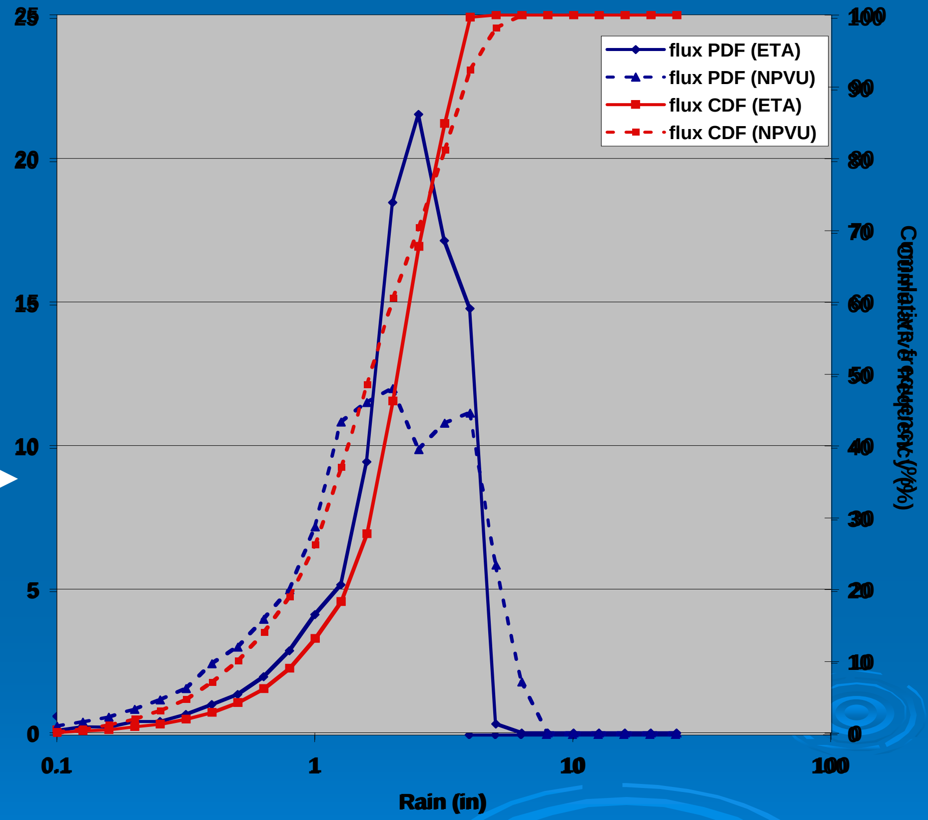
Plot of 24-h rain (in) from 1200 UTC 18 September for Isabel (2003) for Stage4, GFS, ETA

Stage4



Eta





PDF and CDF comparisons of rain flux binned by rain amount

Rogers et al 2004

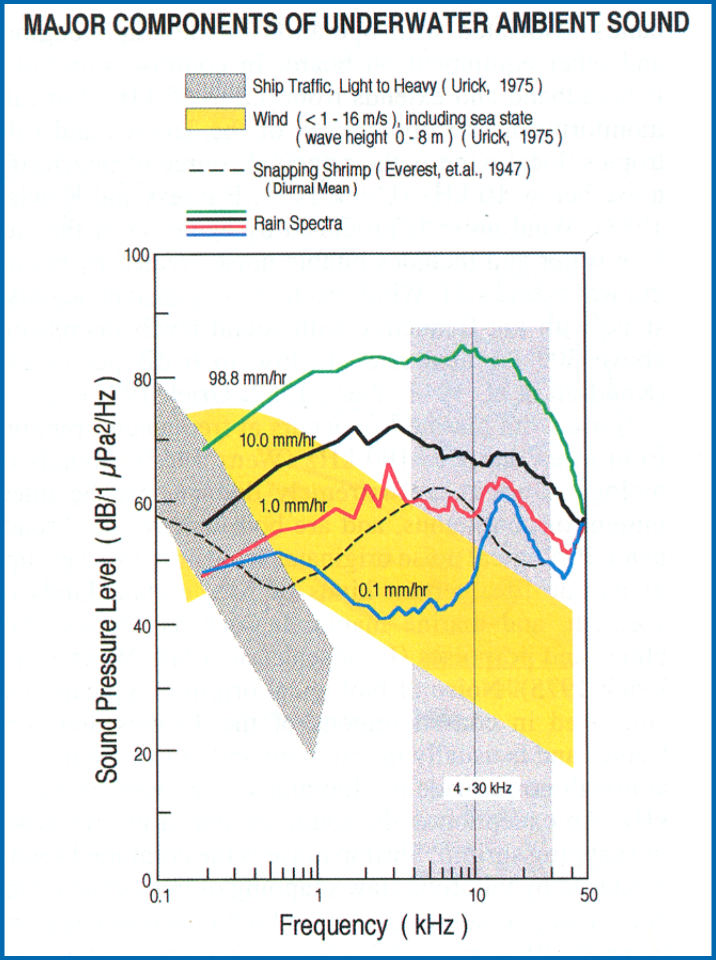
Acoustic Methods

- Falling raindrop creates a bubble in water
- Bubble oscillates, making sound until it comes to equilibrium (or breaks)
- Sound frequency is a function of drop size

- Distribute a set of underwater sound sensors over a wide area. Each sensor has a sample area >> rain gauge, but << radar, but these can be added to obtain a large area.
- Obtain rough (2-point) estimate of DSD
- Estimate the stage of evolution of the rain system from the sound spectra.

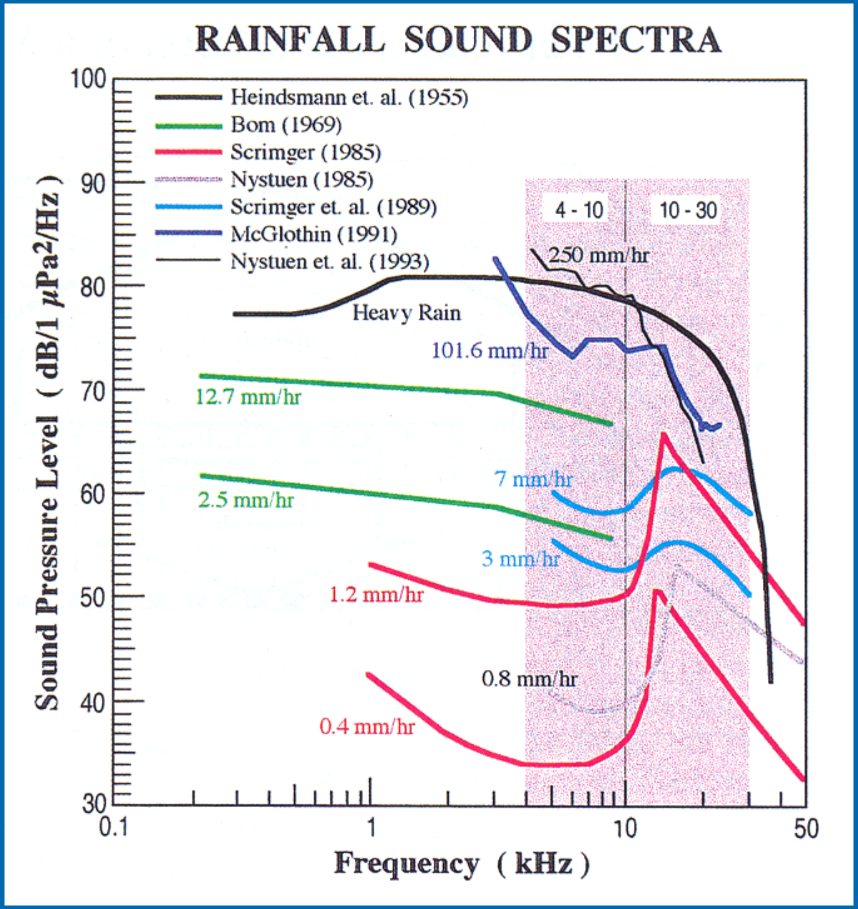
Underwater Noise

- Ships - λ < 1 kH
- Wind
- Shrimp
- Rain - Dominates 1 - 30 kHz band (when present)



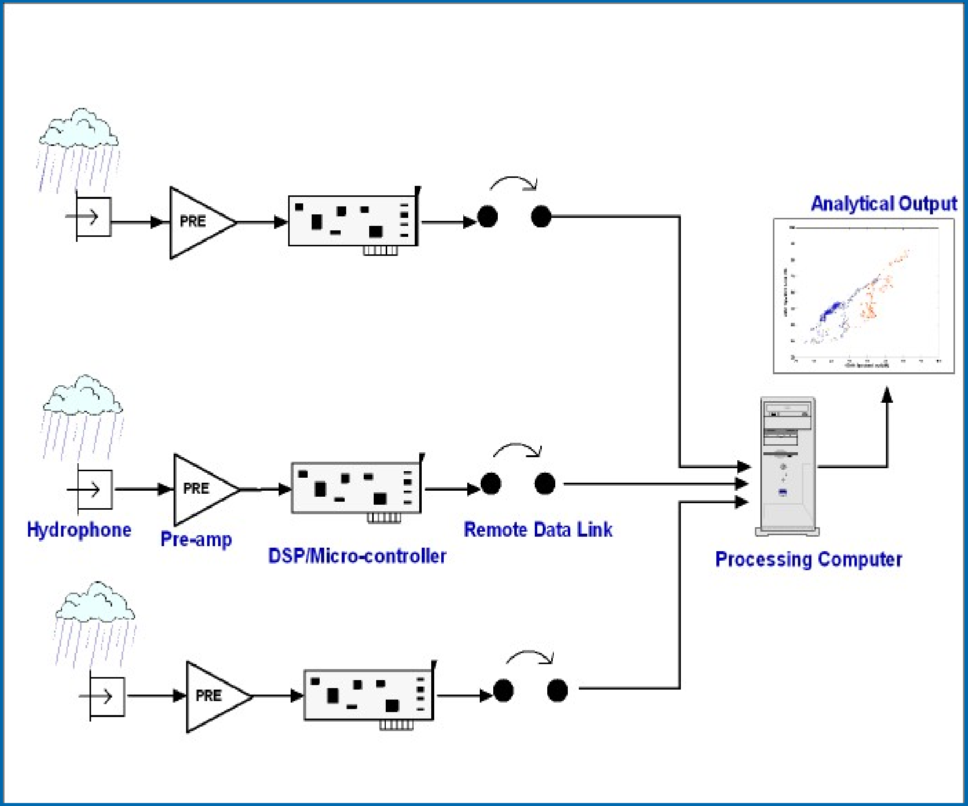
Rain Sound Spectra

- Distinct Shapes
- Convective
- Stratiform
- Wind



Schematic

Acoustical system is both simple and inexpensive to deploy. Data requirements are modest, easily handled by even the oldest, slowest PC's



Summary

- AOML has the foremost experts on tropical cyclone structure, dynamics, and microphysics.
- AOML is developing innovative methods of measuring rainfall for a variety of clients
- AOML is extensively involved in high-resolution tropical cyclone modeling